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AUTHOR	Madrid, George; Powers, Paul; Galvin, Kevin; Kester, Donald L.; Santos, Will; Yamarone, Steve
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ABSTRACT

The mathematics teaching and learning practices of Jaime Escalante, nationally known mathematics teacher, were implemented in a team approach in two high schools and three middle schools in Los Angeles (California). The 13 original project objectives were condensed into restructuring the curriculum, improving student performance, especially in mathematics, and replicating the program. There were nine program components: (1) summer academic instruction for 500 inner-city minority students; (2) Saturday school 29 times in an academic year; (3) afternoon tutoring; (4) peer tutoring; (5) parental involvement; (6) inservice teacher education; (7) curricular development; (8) intersegmental cooperation; and (9) corporate partnership. Mr. Escalante's instructional and motivational practices were studied and described in a guide published for the program. Over the six years of funding for this program, it became clear that minority students whose parents' educational and income levels were low experienced extraordinary success in higher mathematics. It was possible to restructure the curriculum to increase the number of advanced mathematics and science courses, accelerate and improve student mathematics achievement, and replicate the program beyond the two initial high schools. Teachers trained in the program were able to implement these practices successfully. Six appendixes present data on student calculus achievement and program replication, the executive summary of the instructional guide created in the program, and photos of project students and staff. (Contains three tables and five figures.) (SLD)

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ED 424 311

NATIONAL SCIENCE FOUNDATION

FINAL PROJECT REPORT

JAIME ESCALANTE MATHEMATICS AND SCIENCE PROGRAM

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Different sets of results of analyses in this report were presented by Dr. Don Kester at annual conferences of the American Evaluation Association: (1) in Washington, D.C. in 1990, (2) in Chicago in 1991, (3) in Seattle in 1992, and (4) in Dallas in 1993.

1997

UDC 32574

NATIONAL SCIENCE FOUNDATION
FINAL PROJECT REPORT
Jaime Escalante Mathematics and Science Program

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The National Science Foundation Funded
Jaime Escalante Mathematics and Science Project
1993-1996

By
George Madrid, Director
Paul Powers, Associate Director
Kevin Galvin, Internal Program Evaluator
East Los Angeles College Escalante Project
and
Dr. Donald L. Kester, External Program Evaluation Consultant,
Will Santos
Steve Yamarone
Administrative Analysts
Los Angeles County Office of Education, Downey, California

Summary of Completed Project

I Project's Major Thesis:

Evidence of Mr. Jaime Escalante's positive influence on schools, students and teachers in the NSF funded project will be demonstrated through such outcomes as: 1.) The schools will become restructured by increasing the number of advanced math and science courses, and 2.) The students will take and pass the ETS advanced placement test in Calculus AB in significantly greater numbers than before the project. In so doing, project students will qualify for advanced placement credit in colleges and universities in significantly greater numbers.

The two outcomes above would provide evidence that the project teachers became an instructional team, guided by Mr. Escalante; and did learn and implement his successful teaching techniques and attitudes. During Jaime's tenure these trained instructors took valuable lessons back to their participating project schools (two high schools and their three feeder middle schools).

It was always understood at NSF and the Escalante Mathematics Program office that one very important outcome of the program's success would be: 3.) Whether or not the program could be replicated elsewhere.

II The Primary Objectives and Scope:

The thirteen original program objectives could be condensed into the following two major areas: 1.) Restructuring of the curriculum at the junior and senior high schools, and 2.) Improving student performance especially in mathematics.

Improvement of the teaching and learning processes as guided by the master teacher was to be demonstrated by restructuring the curriculum and improving student performance.

The third primary objective was: 3.) Replicating the program elsewhere.

III Approaches used:

The program itself had nine component parts, each of which can be thought of as an approach to reach the three primary objectives mentioned above. In addition, Jaime himself used and passed on a number of teaching and motivating practices which can be thought of as approaches he used in working toward the second objective of improving student performance.

The nine approaches or components of the program were:

1. Summer Program - Summer Programs included basic academic instruction and cultural enrichment activities for 500 inner city, minority students.

2. Saturday School - To support the gains made during the intensive summer programs students attended a specially designed Saturday program 29 times an academic year.

3. Afternoon Tutoring - To reinforce the day's instruction and to keep all students current, the high school and junior high school teachers were available, along with tutors, from 3:00 p.m. to 5:00 p.m. Mondays through Thursdays, fall and spring.

4. Peer Tutoring - Peer tutoring was available during the summer program Saturday sessions, and afternoons fall and spring. Successful students interested in careers as math teachers were trained to provide peer tutoring for high school students.

5. Parental Involvement - Parental involvement is essential to student's success. This project supported a variety of strategies that were effective in creating a climate of parental involvement.

6. In-service - Extensive in-service was provided to teachers, counselors, and parents to develop the expertise needed for a high quality, model program. Program staff enhanced their capabilities to assess student progress and adapt instruction to individual needs. New, pervasive motivational strategies were reviewed. Parents and counselors received training to understand the special needs of the target population.

7. Curricular Development - This project involved original, comprehensive, well planned, systematic, and carefully constructed curricula sensitive to the unique needs of these students. Teachers manuals, curriculum materials, and lesson guides were developed for use by program staff. This led to an increase in the number of advanced courses offered.

8. Intersegmental cooperation - This program brought together teachers, counselors, and staff from junior and senior high schools to improve course articulation and to better address the unique needs of the target population.

9. Corporate Partnership - This project helped these students to explore the linkages between school and work. In cooperation with the project's corporate sponsors mock were undertaken and corporate mentors, career guidance workshops, work experience options, and tours of work sites were provided.

Mr. Escalante's successful teaching and motivating practices were investigated and the results presented in "An Instructional Guide...", a 108 page report previously submitted to NSF, a copy of which is enclosed. In addition an "Executive Summary" to the "Guide" can be found in the appendix of this final project report.

Briefly those successful practices were summarized into three main categories: 1.) Personal characteristics: e.g., "is often funny or humorous," "captures and holds my attention," etc.; 2.) Mathematical skill development: e.g., "calls attention to diagrams," "gives me a lot of math problems to do," etc.; and 3.) Cognitive restructuring including high teacher expectations: e.g., "has helped me see that education is important," "expects me to achieve and do well in math," etc. (Please see Appendix E)

IV Findings and Implications:

Over the six years of NSF funding a clear result was that minority students whose parents' educational and income levels were low experienced extraordinary success in higher mathematics. (See Appendix A and Appendix C)

Furthermore it was clear that it was possible to:

1. Restructure junior and senior high school curriculum so as to increase the number of advanced math and science courses to better serve the needs of minority students (See Appendix B),

2. Accelerate and improve minority student performance in mathematics (See Appendix C), and

3. Replicate the program elsewhere: That is, beyond Garfield and Roosevelt High Schools (See Appendix D).

Mr. Escalante left Garfield High in June 1991 to go to Hiram Johnson High School in Sacramento, California. The National Science Foundation is already aware of the successes of that program since it was funded by the NSF.

Mr. Angelo Villavicencio, a mentee of Mr. Escalante left Garfield in July, 1992. Mr. Villavicencio spent three years at Ruben S. Ayala High School and one year at Don Antonio Lugo High School, both in Chino, California. In both high schools he produced calculus teams that scored well in both number taking and number passing the Calculus AB Advanced Placement test (See Figures 10 and 11 in Appendix D).

Appendix A
Students of The Escalante Mathematics Project

Table 1
Self-reported Ethnic Identity Within Each of Four Populations

Population	Ethnic Identity				
	White not Hispanic	Black not Hispanic	Hispanic	Asian	Native American
United States 1980 [a]	79.00%	12.00%	6.00%	2.00%	1.00%
California 1986 [b]	47.10%	8.70%	33.00%	10.40%	0.80%
Los Angeles County 1989 [c]	26.10%	12.70%	50.45%	10.50%	0.30%
Escalante Math Project 1990 [d]	1.10%	0.50%	91.70%	6.40%	0.30%

Note. *Asians* includes: Japanese, Chinese, Korean, Vietnamese, Filipino, and Pacific Islander. *Native American* includes American Indian and Alaskan Native.

a. U.S. Bureau of the Census, PC 80-I-B6 California or PHC 80-SC-6, California. The total U.S. population in 1980 was 227,757 as reported in U.S. Bureau of the Census, Current Population Reports, series P-25 Nos. 802, 1023, and 1046. Comparable 1990 census data were not available.

b. California Basic Educational Data Systems (CBEDS), 1989-90. Total K-12 enrollment for the state was 4,771,978.

c. California Basic Educational Data Systems (CBEDS), 1989-90. Total K-12 enrollment for the county was 1,366,568.

d. Student respondents were 372 participants in the Jaime Escalante Mathematics Project (1989-1991) who completed a demographic data questionnaire during the project's 1990 summer session.

Appendix A
Students of The Escalante Mathematics Project

Figure 1.
Self-reported Ethnic Identity Within Each of Four Populations

Appendix A
Students of The Escalante Mathematics Project

Table 2
Highest Educational level Reached by Student's More Educated Parent
Within Each of Three Populations

Population	Highest Educational Level				
	Is Not a High School Graduate	Is a High School Graduate	Completed Some College	Is a Four-year College Graduate	Completed an Advanced Degree
Escalante Math Project 1990 [a]	58%	29%	8%	4%	1%
Los Angeles County 1990 [b]	21%	18%	19%	19%	12%
California 1990 [c]	14%	17%	23%	21%	14%

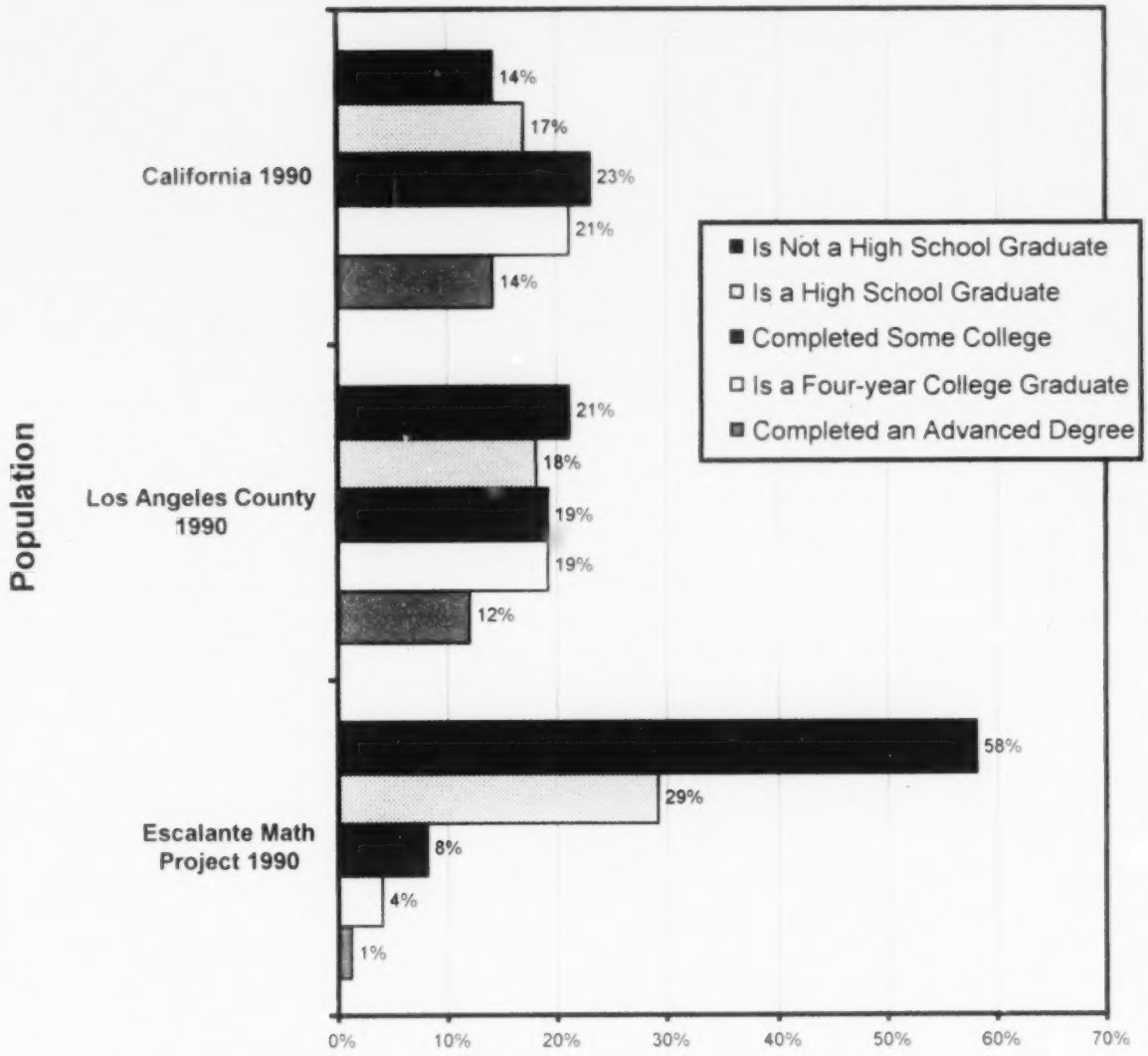
a. Student respondents were 307 participants in the Jaime Escalante Mathematics Project (1989-1991) who completed a demographic data questionnaire during the project's 1990 summer session. That questionnaire included two additional response categories, *attended vocational trade or business school after high school--Less than two years, two years or more*. The eight percent of Escalante project students who selected these categories are included in the category, *is a high school graduate*. Data shown are for the respondent's father who proved to be the more educated parent.

b. California Assessment Program (CAP), 1990. Student respondents were 51,186 twelfth-graders in Los Angeles County.

c. California Assessment Program (CAP), 1990. Student respondents were 212,915 twelfth-graders in California.

Appendix A
Students of The Escalante Mathematics Project

Figure 2.
Highest Educational level Reached by Student's More Educated Parent
Within Each of Three Populations



Appendix A
Students of The Escalante Mathematics Project

Table 3
Annual Household Income Within Three Populations

Population	Annual Household Income						
	$6,999 or less	$7,000-$11,999	$12,000-$15,999	$16,000-$19,999	$20,000-$24,999	$25,000-$37,999	$38,000 or more
Escalante 1990 [a]	14.1%	22.7%	12.9%	16.4%	12.9%	12.9%	8.2%
USA 1988 [b]	7.9%	8.0%	6.9%	6.4%	10.5%	22.6%	37.7%
USA 1980 [c]	6.4%	11.5%	15.4%	17.8%	18.3%	16.4%	14.1%

a. Respondents were 256 parents whose son or daughter were participants in the Jaime Escalante Mathematics Project (1989-1991). These parents completed a demographic data questionnaire during the project's 1990 summer session.

b. Repondents were parents of 23,250 eighth graders who completed a parent questionnaire in 1988 as part of the National Education Longitudinal Study of 1988 conducted by the National Center for Education Statistics (NCES). National Education Longitudinal Study of 1988, Base Year: Student Component Data File User's Manual, Center for Educational Statistics, (1990), p. 59. The family income variable presented here is a composite variable. Eighth graders were mainstreamed students from: 1) public schools, 2) Catholic schools, 3) private religious schools (other than Catholic), and 4) private non-religious schools. Percentages shown have been weighted. The original question provided fifteen responses categories. The fifteen weighted percentages were compressed into the seven categories shown here by means of interpolation as suggested by the project officer at NCES. Because they have been weighted, percentages are believed to reflect a 1988 representative national sample.

c. Respondents were 10,049 high school seniors who completed senior questionnaire in 1980 as part of the High School and Beyond study conducted by the National Center for Education Statistics (NCES). High School and Beyond, (1980), Senior Cohort Third Follow-up, (1986), Volume II, Data File User's Manual, Center for Education Statistics, (1987), pp. 8-55. Percentages shown have been weighted. Data are believed to reflect 1980 representative national sample.

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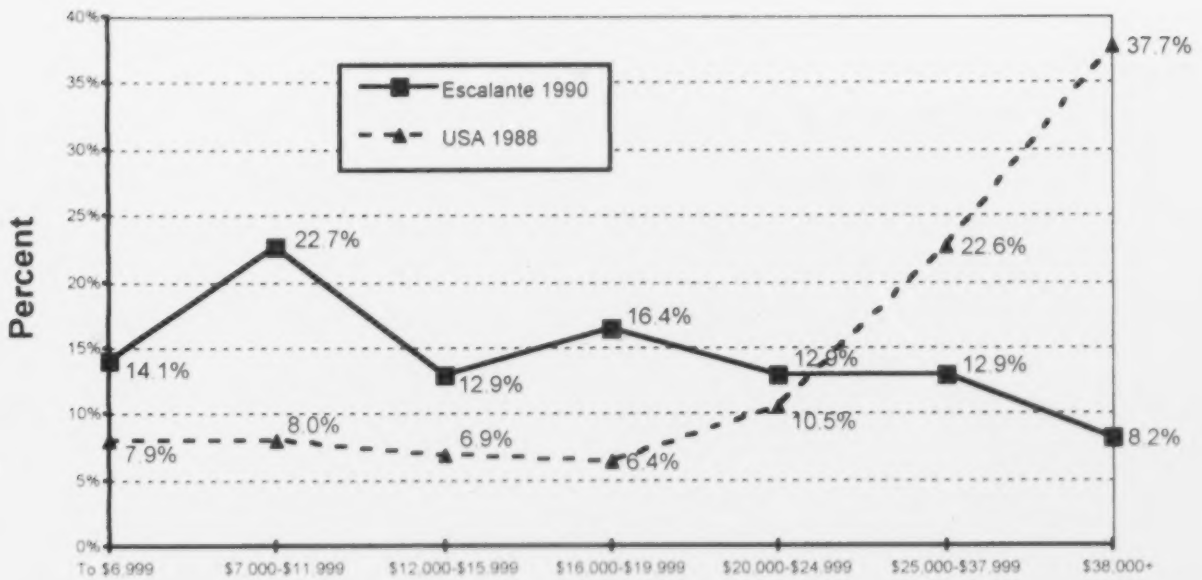
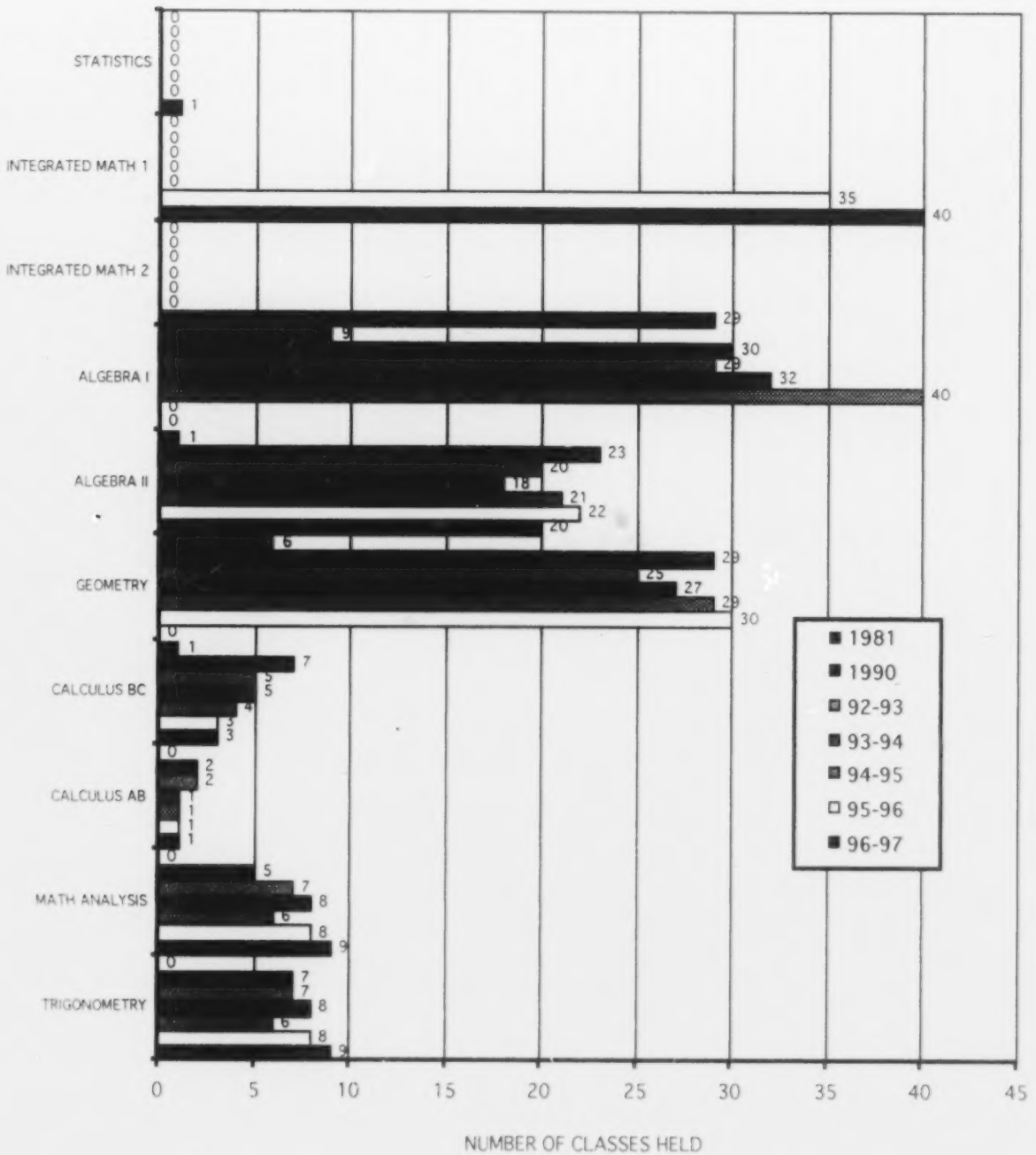
Appendix A
Students of The Escalante Mathematics Project

Figure 3.
Annual Household Income



Appendix B
Restructuring The Schools

Figure 4.
James A. Garfield High School
Total Number of Mathematics Classes Held



Appendix B
Restructuring The Schools

Figure 5.
James A. Garfield High School
Total Number of Science Classes Held

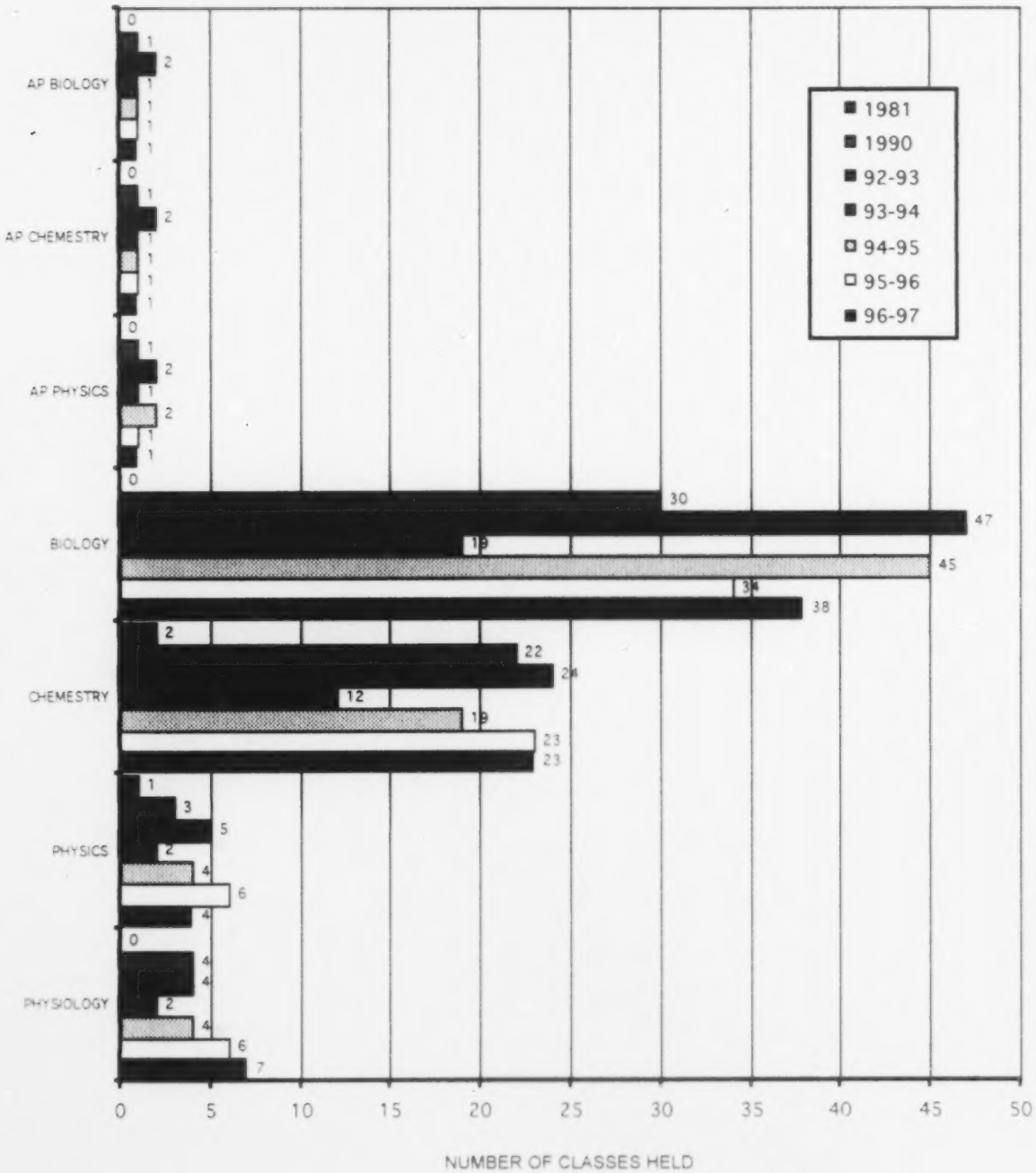
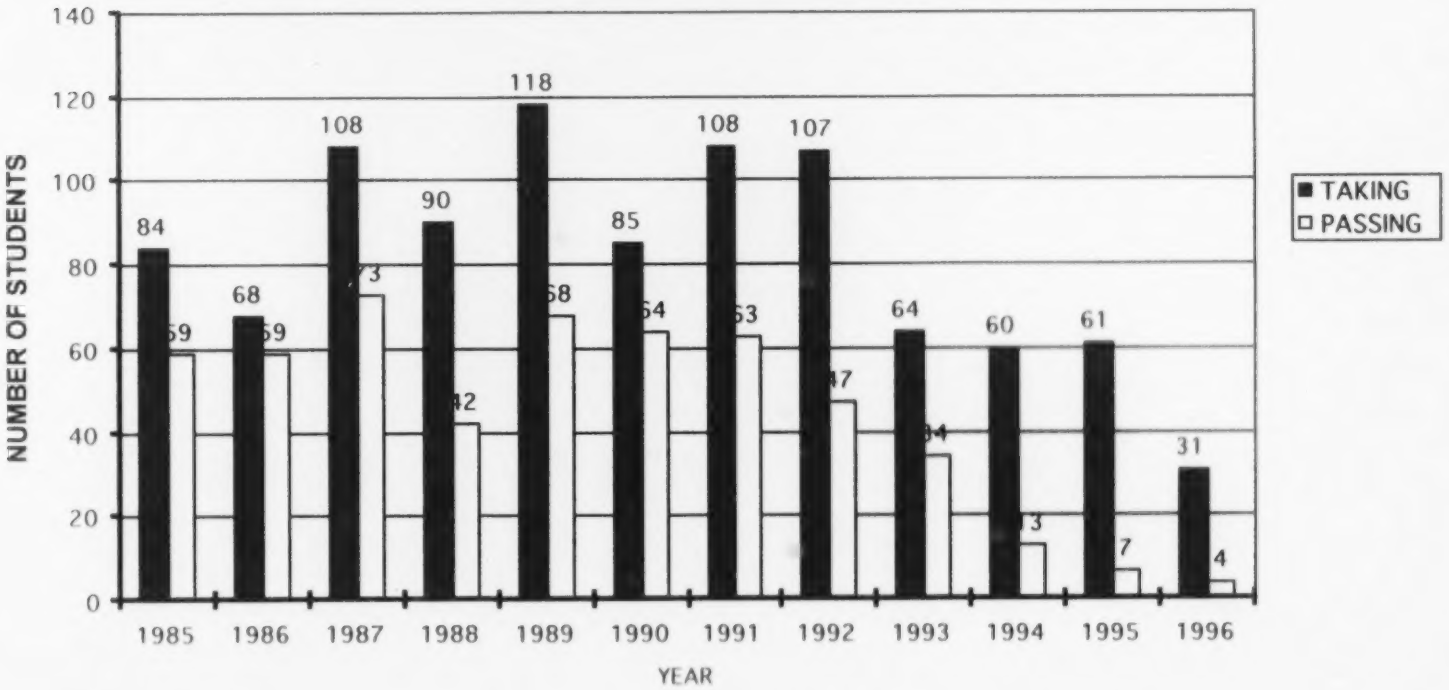


Figure 6.

JAMES A. GARFIELD HIGH SCHOOL

CALCULUS AB

HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



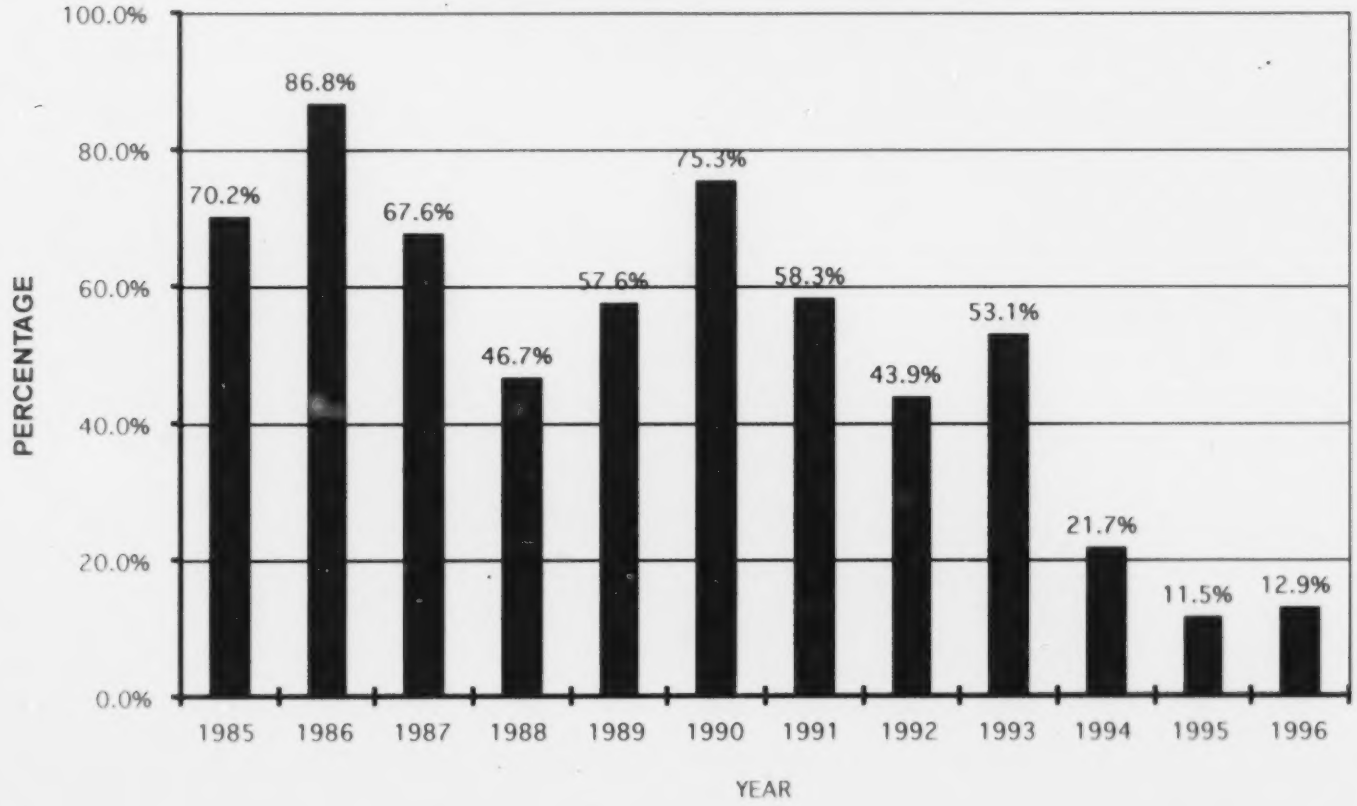
Note. Data on the number of students scoring a "1," "2," "3," "4," and "5" were provided by the California State Department of Education's Research, Evaluation, and Technology Unit.

Figure 7.

JAMES A. GARFIELD HIGH SCHOOL

CALCULUS AB

PERCENTAGE OF STUDENTS PASSING THE HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



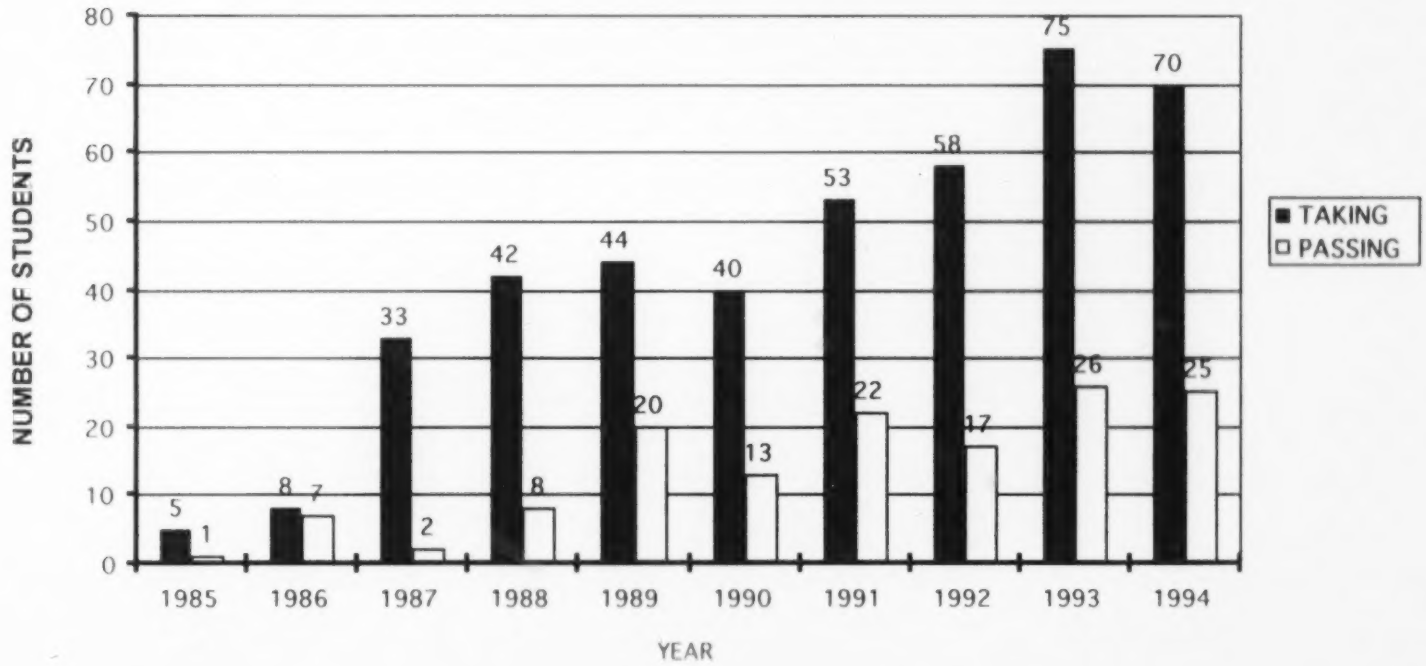
Note. Data on the number of students scoring a "1," "2," "3," "4," and "5" were provided by the California State Department of Education's Research, Evaluation, and Technology Unit.

Figure 8.

ROOSEVELT HIGH SCHOOL

CALCULUS AB

HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



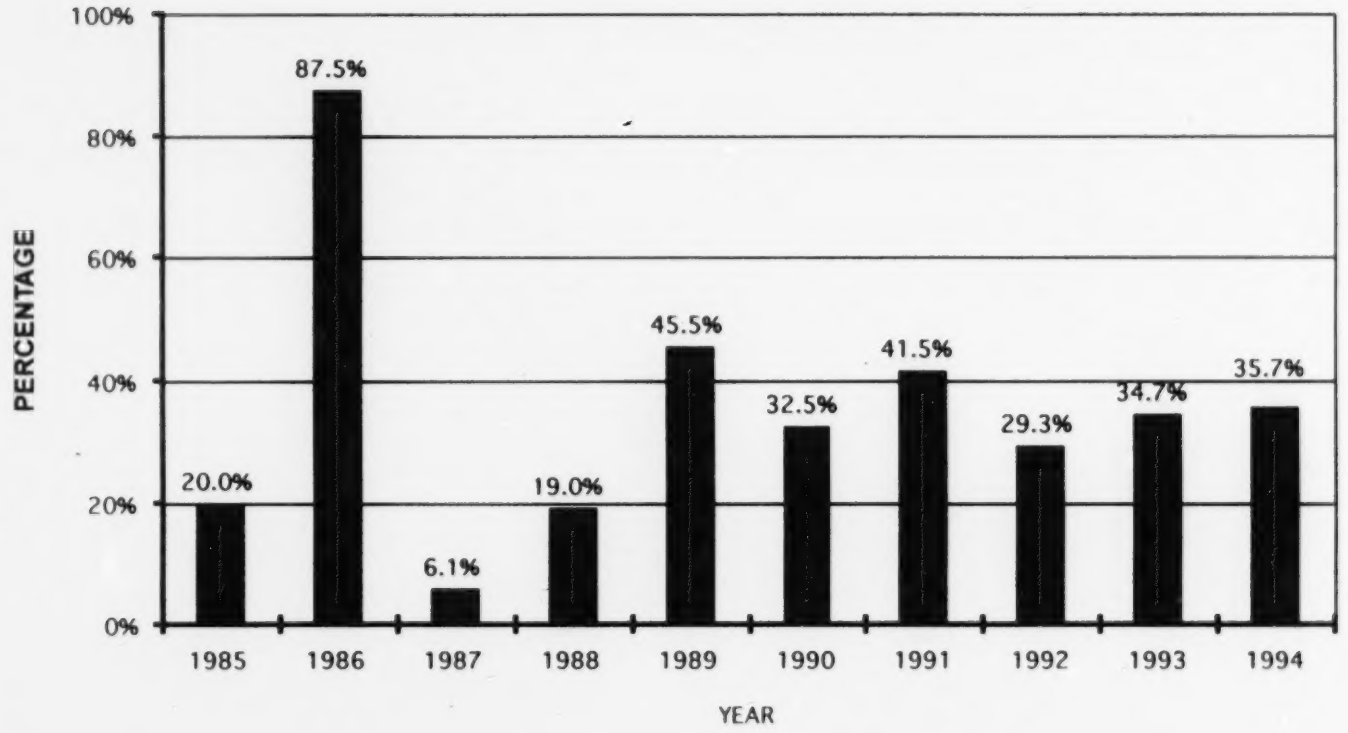
Note. Data on the number of students scoring a "1," "2," "3," "4," and "5" were provided by the California State Department of Education's Research, Evaluation, and Technology Unit.

Figure 9.

ROOSEVELT HIGH SCHOOL

CALCULUS AB

PERCENTAGE OF STUDENTS PASSING THE HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



Note: Data on the number of students scoring a "1," "2," "3," "4," and "5" were provided by the California State Department of Education's Research, Evaluation, and Technology Unit.

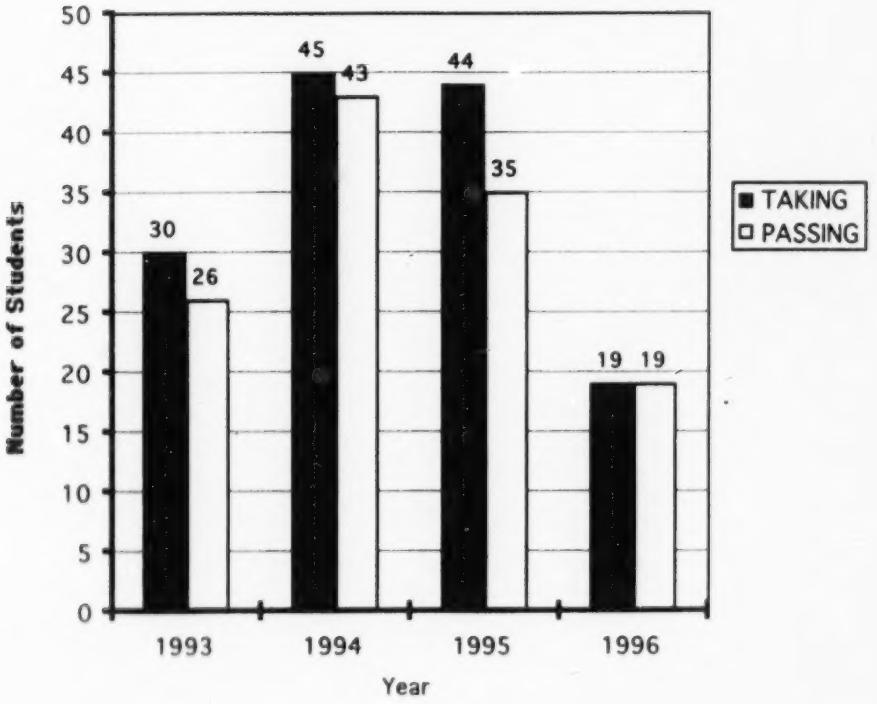
Appendix D
Replicating The Results Elsewhere

Figure 10.

Ruben S. Ayala High School / Don Antonio Lugo High School

CALCULUS AB - REPLICATED PROGRAM

HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



Note: 1993-1995 data from Ruben S. Ayala High School and 1996 data from Don Antonio Lugo High School, Mr. Angelo Villavincencio, Instructor.

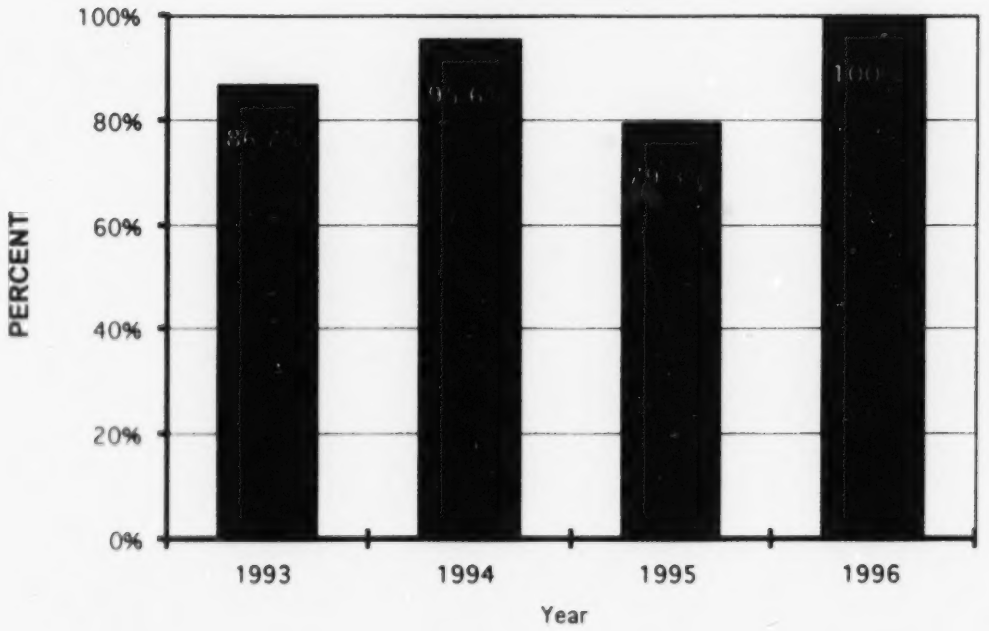
Appendix D
Replicating The Results Elsewhere

Figure 11.

Ruben S. Ayala High School / Don Antonio Lugo High School

CALCULUS AB

PERCENTAGE OF STUDENTS PASSING THE HIGH SCHOOL STUDENT ACHIEVEMENT ON ADVANCED PLACEMENT TESTS OVER TIME



Note: 1993-1995 data from Ruben S. Ayala High School and 1996 data from Don Antonio Lugo High School, Mr. Angelo Villavincencio, Instructor.

Appendix E

EXECUTIVE SUMMARY
for
AN INSTRUCTIONAL GUIDE
Concerning the Highly Successful Teaching & Motivating Practices of Jaime Escalante
Prepared for the Escalante Math & Science Project
at East Los Angeles College

by
Donald L. Kester, Ph.D.
Consultant, Program Evaluation & Research
Los Angeles County Office of Education

A. Exceptional Teacher

He has been called: "a super-teacher," "America's most famous high school teacher," "a mathematics miracle worker," and "the best teacher in America." His extraordinary success in teaching college-level calculus to inner-city, mostly poor, mostly Hispanic high school students in the barrio of East Los Angeles has been chronicled not only in a book, Escalante: The Best Teacher in America, but also in the film, "Stand and Deliver."

B. Context

The study on which the Instructional Guide is based is but a small part of a much larger effort known as, "The Jaime Escalante Mathematics and Science Project." Now in its fifth funded year, the project reaches more than 500 students in two high schools and three junior high schools.

C. Study Methodology to Produce the Instructional Guide

Using a program evaluation technique known as "data source triangulation," this investigation sought to identify and describe Jaime Escalante's highly successful teaching and motivating practices.

Figure 1
Data Source Triangulation

This technique involved asking Escalante's calculus students, who had been with him for three or four years, to complete a questionnaire in which they would rank each seventy-five (75) statements on research - proven teacher practices and attributes as more or less like him. (The scale went from -9 to +9.) Those statements had been derived primarily from research findings found in three sources: What Works: Research About Teaching Learning (USDOE, 1987), Motivation: What Research Says to the Teacher (NEA, 1990), and "The Jaime Escalante Math Program" (Escalante and Dirmann, 1990).

Two very knowledgeable colleagues of Escalante, both of whom had observed him extensively also completed the questionnaire. One observed him teaching every day for six (6) weeks. Finally, in a videotaped interview, Escalante was asked about the top thirty-eight (38) statements from the list rank-ordered by his students; e.g., did he agree with or disagree with each statement, and what additional methods or practices did he use.

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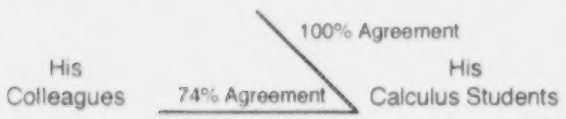
By either questionnaire or interview, the three sources of information-Jaime, his colleagues, and calculus students-responded to the same thirty-eight (38) statements. Three sources responding to the same prompts gives us the data source triangulation used to create the Instructional Guide which is now part of the Educational Resources Information Center (ERIC) System. The ERIC information system is sponsored by the Office of Educational Research and Improvement within the U.S. Department of Education. The ERIC number is ED 358 173.

Figure 2
Data Source Triangulation



D. Results

A 100 percent level of agreement was found between the list of the top thirty-eight (38) statements rank-ordered by Escalante's calculus students and affirmative comments made by Escalante himself. In other words, Escalante agreed that all thirty-eight statements identified by his calculus students as more like him and his teaching were correct; i.e., they did,in fact describe either teaching or motivating practices he uses or a characteristic of him as a person that he believes is true.

In the interview, he added support from parents and school administrators as important to student success. (See pages 47 and 48 in the Guide.) A seventy-four percent (74%) level of agreement was found between the ranking of the top thirty-eight (38) statements done by his calculus students when compared with the ranking done by his colleagues.

E. Discussion

Escalante's calculus students had observed him over a longer period of time than anyone else. Of the seventy-five (75) research-based statements they identified thirty-eight (38) as being more like him and his teaching and motivating. But a list of thirty-eight (38) statements is hardly concise. One of the principles of the scientific method is that of "parsimony," i.e., the use of "Occam's razor." This principal demands simplicity. But, inventing or a conceptual frame of reference is risky business. There is always the possibility that it will say as much about the inventor than the phenomena being studied. The following conceptual taxonomy should be considered as only one working hypothesis; only one suggested taxonomy among several that might be offered. In this taxonomy there are three main categories: 1. Personal Characteristics, 2. Mathematical Skill Development, and 3. Cognitive Restructuring, including Teacher Expectations. The actual statements and their categories are as follows:

1. Personal Characteristics:
Mr. Escalante: "is often funny or humorous," "is enthusiastic," "is energetic," "is an excellent mathematician," "is cheerful," "is friendly toward me," "captures and holds my attention," and "believes in me."

2. Mathematical Skill Development:
Mr. Escalante: "calls attention to diagrams, graphs, photos, or illustrations that not only relate to the lesson but also help me learn and remember," "has taught me rules and principles and the conditions under which they apply so I can solve math problems," "gives me a lot of math problems to do," "requires that faster learners put forth effort too; he won't let them just 'coast'," "gives me the help I need when I get 'stuck'," "takes us through the steps needed to solve a problem and explains the purpose of each step," "has helped me learn how to think through a word problem before I begin working on it; to analyze the challenges I face and explore

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alternative strategies before I start to work," and "has taught me to estimate answers to math problems so that I can reject unreasonable answers and know when an answer is 'in the ballpark'."

3. Cognitive Restructuring:
Mr. Escalante: "believes my first priority is to learn," "puts academics first," "has helped me understand that employers will want me to have a solid preparation in math, reading, writing, and problem solving," "has helped me see that education is important," "encourages me to try harder by reminding me that people beyond our school are paying attention to how well I do," "has helped me understand that I learn more in rigorous, tough courses than in courses that are easier," "has encouraged public recognition for students who succeed and promoted a sense of school pride," "helps me enjoy math," "has helped me set higher goals for myself in life," "helps me see myself as a 'winner'," "has helped me understand that I can become qualified for any job I want," "has helped me set higher goals for myself in math," "has helped me become more interested in math," "understands the world I will face after high school," "helps me plan and strive for excellence." **Teacher Expectation--Mr. Escalante**: "expects me to work hard," "expects me to achieve me to attend class, come to class on time, and meet the assignment deadlines," "expects that I can and will learn a lot of math," "expects me to be honest, courteous, and to show respect for others," "expects me to spend a lot of time on math," and "expects and rewards my academic success."

F. Possible Replication of the Program
It would be nice if America had an army of at least a thousand Jaime Escalates who could go into barrio high schools all over America, reverse the high dropout rate and lead those inner city high school students to academic excellence. But, of course, the truth is, we don't have a thousand Jaimes; and given the fact that he is over 60 years old, and therefore already beyond normal retirement age, America may not have him as a full-time math teacher for very much longer.

Several questions arise. Can the original Escalante Math Project based at East Los Angeles College continue to be successful without him? Could the program be repeated elsewhere? Jaime has given his answer:

> I have described the elements of my program. I believe that they can be duplicated elsewhere with ease. The key for the teacher as well as for the student is hard work. Hard work makes the future. When hard work is combined with love, humor, and a recognition of the **ganas**-the desire to learn, the ability to sacrifice, the wish to get ahead-that burns in our young people, the stereotypes and the barriers begin to crumble . . . I always have to laugh when someone suggests that my program is dependent upon one teacher's personality (my own) and could never serve as a model for use in other schools. It just shows how far away we have drifted from the fundamentals of teaching (Escalante and Dirmann, 1990, pp. 6,14).

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Appendix F

The Jaime Escalante Math Project

Project Students

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Appendix F

The Jaime Escalante Math Project

Project Teachers and Staff

Left to right:
Front Row: Dawn Bova, Jaime Escalante, George Madrid, and Joy Shiriraishi; Second Row: Alice Green, Kevin Galvin, Steve Aguilar, and Dallas Russell; Third Row: Angelo Villavicencio, Alice Maldonado, Roy Marquez, and George Campos; Back Row: Felipe Caceres, Paul Powers, Valentin Aguilera, and Sal Quezada.

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